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ABSTRACT

Information collected as part of the International Assessment of Educational Progress II (IAEP II) about learning in Alberta (Canada) is provided, including information on the educational and cultural factors associated with student achievement and information on student attitudes, backgrounds, and experiences. Results for all participating countries (20 in science and mathematics and 9 in geography) have been distributed. This report indicates what 13-year-olds in Alberta have been able to achieve in science, mathematics, and geography. In Alberta, 119 randomly selected schools participated. Alberta students (n=1,459) did very well in science, scoring in the top one-third in all comparisons. The mathematics achievement of the 1,422 students was not as high, ranking in the middle third both nationally and internationally. Those who took the geography test, a brief assessment, scored in the top third in all comparisons. Results for participating countries are summarized for comparisons with Alberta and other Canadian provinces. Results and score distributions are presented in 27 tables. Appendix 1 gives an overall summary of test administration, and Appendix 2 describes quality control procedures. (SLD)

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Context for Learning

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IAEP Alberta Report

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This document was written primarily for:

Students	
Teachers	✓
Administrators	✓ (Superintendents, Principals)
Parents	
General Public	
Others (Specify)	

Distribution of Reports:

In February 1992 two IAEP reports, *Learning Science* and *Learning Mathematics* were distributed as follows:

- one copy to each school superintendent
- one copy to each participating school
- other copies to organizations and libraries

This report, *Context for Learning: IAEP Alberta Report*, has been distributed as follows:

- one copy to each school superintendent
- one copy to each school that participated in the study
- other copies to organizations and libraries

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Acknowledgments

The completion of the IAEP is the result of the contribution and support of many individuals throughout the world. Particular thanks are due to Dr. Nancy Mead at Educational Testing Service, Princeton, who saw IAEP to a successful conclusion. This report draws extensively on the two international reports released in February 1992: *Learning Mathematics* and *Learning Science* by Lapointe, Mead, and Askew.

In Alberta, a special thank-you goes to the teachers, administrators, and students in the 119 schools that participated in IAEP. The support and co-operation of all involved contributed greatly to our successful participation.

Dennis Belyk
Provincial IAEP Coordinator

CONTENTS

SECTION 1: PROJECT OVERVIEW

Introduction 1
Overview of IAEP II 1
Highlights of Alberta's Participation 1
"Context for Learning" Highlights 2

SECTION 2: COUNTRIES AND THEIR EDUCATION SYSTEMS 4

SECTION 3: SCIENCE RESULTS

Summary of Science Information 8
Science Performance of 13-Year-Old Students 9
Curriculum Emphasis 12
Classroom Characteristics 14
Students and Their Homes 21

SECTION 4: MATHEMATICS RESULTS

Summary of Mathematics Information 29
Mathematics Performance of 13-Year-Old Students. 30
Curriculum Emphasis 33
Classroom Characteristics 35
Students and Their Homes 42

SECTION 5: GEOGRAPHY RESULTS

Summary of Geography Information 49
Geography Performance of 13-Year-Old Students 49
Communication with Parents and Student Activities. 53

FINAL WORD 54

APPENDIX 1

Overall Summary of Test Administration by Country and Canadian Province for Age 9 and Age 13 55

APPENDIX 2

Quality Control Procedures 56

LIST OF FIGURES

EDUCATION SYSTEMS

Figure 2.1. Education Systems and Average Percent Correct 4
Figure 2.2. Problems in School 6

SCIENCE

Figure 3.1. Distribution of Percent Correct Scores by Country/Province 10
Figure 3.2. Emphasis for All Major Topics 12
Figure 3.3. Teaching Practices and Average Percent Correct 14
Figure 3.4. Relationship of Teaching Practices and Average Percent Correct Within Populations 16
Figure 3.5. Teaching Materials and Average Percent Correct. 17
Figure 3.6. Teacher Background, Classroom Organization and Average Percent Correct. 19
Figure 3.7. Home Characteristics and Average Percent Correct. 21
Figure 3.8. Relationship of Home Characteristics and Average Percent Correct Within Populations 22
Figure 3.9. Home Activities and Average Percent Correct. 24
Figure 3.10. Relationship of Home Activities and Average Percent Correct Within Populations 25
Figure 3.11. Attitudes Toward Science and Average Percent Correct. 27

MATHEMATICS

Figure 4.1. Distribution of Percent Correct Scores by Country/Province 31
Figure 4.2. Emphasis for All Major Types. 33
Figure 4.3. Teaching Practices and Average Percent Correct 35
Figure 4.4. Relationship of Teaching Practices and Average Percent Correct Within Populations 36
Figure 4.5. Teaching Materials and Average Percent Correct. 38
Figure 4.6. Teacher Background, Classroom Organization, and Average Percent Correct. 40
Figure 4.7. Home Characteristics and Average Percent Correct. 42
Figure 4.8. Relationship of Home Characteristics and Average Percent Correct Within Populations 43
Figure 4.9. Home Activities and Average Percent Correct. 44
Figure 4.10. Relationship of Home Activities and Average Percent Correct Within Populations 45
Figure 4.11. Attitudes Toward Mathematics. 47

GEOGRAPHY

Figure 5.1. Distribution of Percent Correct Scores by County/Province. 50
Figure 5.2. Percentage of Students Who Report Studying Topics and Average Percent Correct. 51
Figure 5.3. Communication With Parents, Student Activities and Average Percent Correct. 53

SECTION 1: PROJECT OVERVIEW

This report provides additional information, collected as part of the International Assessment of Educational Progress II (IAEP II), about learning in Alberta. It includes information on the educational and cultural factors associated with student achievement, as well as information on student attitudes, backgrounds, and experiences. Results for all participating countries are presented in two IAEP reports: *Learning Mathematics* and *Learning Science*. Copies of these reports have been distributed to all school superintendents and to the schools that participated in the study.

This report identifies what Alberta's 13-year-olds were able to achieve. As well, Alberta results are reported in relation to other Canadian provinces and to some interesting international comparisons. Appendices 1 and 2 summarize test administration procedures.

Overview of IAEP II

In 1990-91, a total of 20 countries, including nine Canadian provinces, surveyed the mathematics and science performance of their 13-year-old students. An optional short probe of geography achievement and an experimental mathematics and science performance-based assessment of 13-year-olds were also administered by some participants. Finally, 14 countries selected the additional option to assess 9-year-olds in the same subjects.

Participants (all Canadian provinces except Prince Edward Island participated):

Brazil	Mozambique	Canada:	Alberta
China	Portugal		British Columbia
England	Scotland		Manitoba
France	Slovenia		New Brunswick
Hungary	Soviet Union		Newfoundland
Ireland	Spain		Nova Scotia
Israel	Switzerland		Ontario
Italy	Taiwan		Quebec
Jordan	United States		Saskatchewan
Korea			

All participants conducted the mathematics and science assessment of 13-year-olds—the main part of the project. Nine countries, including Alberta and seven other Canadian provinces, participated in the optional assessment of geography at the 13-year-old level.

- As an additional component of the study, 14 countries including four Canadian provinces participated in the optional assessment of mathematics and science at the 9-year-old level: England, Hungary, Ireland, Israel, Italy, Korea, Portugal, Slovenia, Scotland, Spain, Soviet Union, Taiwan, the United States, and British Columbia, New Brunswick, Ontario, and Quebec.

- Four countries (Taiwan, Scotland, England, Soviet Union) and five provinces (Alberta, Ontario, Saskatchewan, British Columbia, Nova Scotia) participated in the performance task (hands-on) assessment of 13-year-olds. The performance assessment report, which will include Alberta's results, is forthcoming.

Each country or province that participated did so for its own reasons. In Alberta, the study provided an opportunity to gauge what our students are able to demonstrate they can do in relation to the skills and knowledge demonstrated by students in other places around the world. This information permits reflection on the expectations described in Alberta's programs of studies as we examine the standards that they communicate.

Highlights of Alberta's Participation

In Alberta, 119 randomly selected schools, participated in the project. Students that were 13 years old were randomly sampled from these schools to write either the mathematics or the science test booklet.

- 1422 Alberta students completed the mathematics booklet, plus 12 geography questions.
- 1459 Alberta students completed the science booklet, plus 12 geography questions.

The geography component consisted of 24 questions; 12 were placed along with the mathematics booklet and 12 with the science booklet.

Alberta's Performance

Science (13-year-olds):

Alberta did very well. Not only did Alberta students score in the top one-third in all comparisons, they ranked first in Canada and third internationally.

Mathematics (13-year-olds):

Alberta did not perform as well in mathematics. Results are in the middle third when compared nationally and internationally. In particular, Alberta's scores in Geometry, and Algebra and Functions were the lowest (middle or bottom third in comparisons); scores for Numbers and Operations, Measurement, and Data Analysis and Statistics were higher (mostly in the top third of all scores).

Geography (13-year-olds):

Results show Alberta students in the top third in all comparisons. Results are very good considering there is not a specific geography curriculum in Alberta. Geography knowledge and skills are integrated mostly into social studies and science.

- Caution: The geography component had only 24 questions and was conducted to collect only a minimum of information on geography skills. It should not be interpreted as an extensive assessment of geography knowledge and skills.

"Context for Learning" Highlights

Data that describe the different contexts for learning can contribute to an understanding of achievement results. Of particular interest are patterns that might emerge in relation to high student performance or low student performance. The IAEP II study collected information from students and school principals about some of the characteristics of educational systems, classrooms, homes, and students that might contribute to the thoughtful interpretation of achievement results. Throughout this report, detailed information is presented about the learning contexts for Alberta, for other Canadian provinces, and for some countries with interesting comparisons. This information provides insights that are helpful in understanding the impact of educational and cultural factors on student achievement and learning. A few highlights are listed below.

Amount of Instruction and Class Size

Generally, the highest performing countries also have the most instructional days in their school year. Taiwan, Korea, and Switzerland follow this pattern.

In this study, student achievement does not appear to be related closely to class size. Of particular note are Korea and Taiwan, both of which have very large class sizes and high performance scores.

Home Characteristics

Science and mathematics performance in IAEP II was directly related to the number of books in students' homes. Students with access to a larger number of books achieved higher scores. This is consistent for all countries and provinces that participated.

There seems to be a difference between North America and other countries in the impact on scores when parents show an interest in science. In North America, students score higher when parents show an interest in science. This is not necessarily the case in other parts of the world. Why this difference exists can only be hypothesized, taking into consideration the cultural differences that exist between countries.

How Students Spend Their Time

Children who read more do better; those who watch more television do not do as well. These findings were consistent for both science and mathematics. However, a clear pattern for student performance in relation to the amount of time students spend on homework did not emerge. It is interesting to note that North American results show either no impact or a negative influence on results as students spend more time on all homework. In other countries, there is either no impact or a positive one. This suggests there may be a qualitative difference in the type of homework North American children do compared with children in other countries.

Student Attitudes

In nearly every country or province, students with positive attitudes toward mathematics and science do better than those who are less positive. While this is not surprising, the importance of a positive attitude is reinforced as a key contributor to higher results.

Calculators and Computers

Students in Canada and the United States have or have access to calculators and computers more so than students in most other countries. But, the study shows that this advantage has not generally resulted in North American students achieving higher scores.

SECTION 2: COUNTRIES AND THEIR EDUCATION SYSTEMS

Information about schools and schooling in participating countries follows. The way in which education systems deliver programs varies widely, as does the cultural context within which the programs operate.

Figures 2.1 and 2.2 provide data on class size, amount of instruction and other categories for which information was collected in relation to achievement.

Figure 2.1. Education Systems and Average Percent Correct

	Average % Correct in Science	Average % Correct in Math	Average Days of Instruction in Year*	Avg. Minutes of Instruction in School Each Day*	Average Class Size for Grade 8*	% of Schools With One or More Serious Problems**
Science Rank Order/IAEP Average	67	58				
Korea	78	73	222	264	49	24
Taiwan	76	73	222	318	44	10
Switzerland	74	71	207	305	18	11
Hungary	73	68	177	223	27	32
Soviet Union	71	70	198	243	22	72
Slovenia	70	57	190	248	25	50
Emilia-Romagna, Italy	70	64	204	289	21	18
Israel	70	63	215	278	32	46
Canada	69	62	188	304	25	13
France	69	64	174	370	25	29
Scotland	68	61	191	324	24	23
Spain	68	55	188	285	29	33
United States	67	55	178	338	23	5
Ireland	63	61	173	323	27	39
Jordan	57	40	191	260	27	63
Special Populations						
England	69	61	192	300	22	24
China	67	80	251	305	48	43
Portugal	63	48	172	334	25	56
Sao Paulo, Brazil	53	37	181	271	38	60
Fortaleza, Brazil	46	32	183	223	32	62
Mozambique	N/A	28	193	272	51	92

* School Questionnaire

** Problems identified in the school questionnaire included overcrowding, shortage of textbooks, shortage of educational materials, student absenteeism, student discipline, vandalism. (See Figure 2.2 for details.)

N/A Information not available.

Figure 2.1 (continued). Education Systems and Average Percent Correct

	Average % Correct in Science	Average % Correct in Math	Average Days of Instruction in Year*	Avg. Minutes of Instruction in School Each Day*	Average Class Size for Grade 8*	% of Schools With One or More Serious Problems**
Canadian Populations/IAEP Average	67	58				
Alberta	74	64	190	315	23	5
British Columbia	72	66	190	304	25	19
Quebec - French	71	69	181	303	28	11
Saskatchewan - English	70	62	194	297	21	11
Quebec - English	69	66	181	302	26	14
Nova Scotia	69	60	187	293	24	18
Manitoba - English	69	58	192	312	21	10
Ontario - English	67	58	187	304	27	11
Manitoba - French	67	63	194	313	20	13
New Brunswick - English	66	58	185	296	23	11
Newfoundland	66	59	187	289	24	35
Saskatchewan - French	65	68	195	309	20	21
New Brunswick - French	64	61	188	303	24	27
Ontario - French	60	53	187	300	22	20

* School Questionnaire

** Problems identified in the school questionnaire included overcrowding, shortage of textbooks, shortage of educational materials, student absenteeism, student discipline, vandalism. (See Figure 2.2 for details.)

Observations (Figure 2.1)

Education systems vary from country to country but not necessarily in patterns that explain high and low achievement. For most countries, the average number of days of instruction in a year varies from 175 to 222. In China, the average of 251 days of instruction is dramatically higher than the norm. Korea and Taiwan also show a relatively high number, whereas Ireland and France show the lowest. Alberta shows a higher number than the Canadian average but in general, students across Canada have about the same number of instructional days each year.

The number of minutes spent on instruction each school day must be taken into account when comparing the number of instructional days. For example, the United States shows a slightly lower than average number of instructional days but reports a higher number of minutes of daily instruction compared with the overall average. France has the longest school day, compensating for the fewer number of instructional days each year. Alberta has a higher number of instructional minutes per day compared with other provinces. Similarly, Taiwan, France, Scotland, the United States, Ireland, and Portugal report a high number of instructional minutes per day compared with most other countries.

Student performance in this study does not appear to be related to class size. Of all participating populations, Switzerland has the lowest class size, with 18 students, followed by Italy, England, North America and the Soviet Union. Alberta reports an average of 23 students in each class. China, Korea, Taiwan, and Mozambique report large class sizes.

Figure 2.2 shows the degree to which different school-related problems exist in different countries.

Figure 2.2. Age 13: Problems in School*

	Number of Schools Participating	Percent of Schools Reporting Problems as Moderate or Serious:					
		Overcrowding	Textbooks	Educational Materials	Student Absenteeism	Student Discipline	Vandalism
Science Rank Order /IAEP Average							
Korea	110	37	1	51	14	45	18
Taiwan	108	28	0	21	2	8	17
Switzerland	397	33	6	9	4	16	17
Hungary	144	29	6	31	12	23	31
Soviet Union	138	74	32	75	24	20	16
Slovenia	114	52	13	65	7	20	28
Emilia-Romagna, Italy	90	12	2	39	7	26	27
Israel	110	61	13	25	8	22	24
Canada	1373	31	13	22	11	9	4
France	103	46	4	19	12	24	19
Scotland	92	10	24	18	22	12	10
Spain	109	36	10	47	20	30	19
United States	96	16	7	13	18	16	8
Ireland	110	41	14	46	23	13	10
Jordan	106	63	13	48	20	13	18
Special Populations							
England	83	28	31	33	9	19	8
China	119	41	4	40	9	12	15
Portugal	89	47	22	75	34	17	16
Sao Paulo, Brazil	108	22	41	60	38	51	54
Fortaleza, Brazil	118	23	58	53	24	38	47
Mozambique	13	59	85	84	39	38	77

* School Questionnaire

Figure 2.2 (continued). Age 13: Problems in School*							
	Number of Schools Participating **	Percent of Schools Reporting Problems as Moderate or Serious:					
		Overcrowding	Textbooks	Educational Materials	Student Absenteeism	Student Discipline	Vandalism
Canadian Pops/IAEP Average							
Alberta	119	30	6	17	12	6	1
British Columbia	105	25	13	23	34	15	12
Quebec - French	106	35	2	11	10	15	4
Saskatchewan - English	140	27	12	13	15	8	2
Quebec - English	83	22	9	18	13	10	8
Nova Scotia	108	38	8	20	14	17	7
Manitoba - English	115	19	8	15	9	10	6
Ontario - English	123	34	18	25	5	4	4
Manitoba - French	46	25	22	37	11	11	8
New Bruns. - English	100	28	11	32	14	28	12
Newfoundland	108	33	6	41	32	13	11
Saskatchewan - French	30	41	14	41	6	10	6
New Brunswick - French	70	44	13	31	22	28	5
Ontario - French	117	31	17	27	12	12	7

* School Questionnaire

** The total number of schools for all provinces is 3 less than reported for Canada as a result of 3 schools being dropped due to special circumstances.

Observations (Figure 2.2)

The four lowest performing populations report a high incidence of problems in their schools, as do two higher performing populations, Slovenia and the Soviet Union. Alberta results show that a relatively low percentage of schools perceive the variety of problems surveyed to be of a moderate or serious nature. It is interesting to note that the Soviet Union has an average class size of 22 students, and yet 74% of schools report overcrowding to be a moderate or serious problem. Generally, the most serious problem reported by each population is overcrowding. Student discipline appears to be of less concern when compared with overcrowding and general availability of educational materials. In addition, a high percentage of schools in some countries report a shortage of educational materials as being a moderate to serious issue. For example, 51% of Korean schools report this to be a problem.

SECTION 3: SCIENCE RESULTS

In Alberta, 1459 students were sampled to write the science portion of the study and to answer related background questions. Interesting aspects of curriculum-related information, classroom characteristics, students and their homes, and education systems are presented.

Summary of Science Information

Two areas in which Alberta stands out are Nature of Science, and Integrates Science. Students were required to generalize, hypothesize, and reason by synthesizing specific information. The Alberta results are interesting when considered with the information that shows that Alberta students do experiments on their own more often than students in other participating countries do.

The emphasis that schools place on many of the sub-topics varies dramatically and cannot consistently be linked to performance. Curiously, Alberta schools report a lower emphasis on Nature of Science sub-topics (when compared with the Canadian average), and yet Alberta ranked first overall. The results that show Alberta students conduct experiments fairly often may support Alberta's high overall performance.

The findings that describe classroom factors highlight the variation in practices among countries. The majority of Alberta's 13-year-old students tend to spend one hour on science homework each week, do not have weekly science quizzes, listen to science lessons approximately 45% of the time, and conduct experiments fairly often. Science classes are never based on ability in Alberta, and only 2% of Alberta schools report that they do not have a science laboratory. Approximately one-half of Alberta schools use specialists to teach science, and over 65% of those teaching the course have taken some post-secondary training in science. Alberta spends more time on science instruction each week compared to the Canadian average. All these factors indicate a greater focus on science in Alberta than in most other countries. Perhaps this emphasis helps to explain the high performance of Alberta students.

The information reported about students and their homes shows variation between countries. Nine percent of Alberta's 13-year-olds report receiving instruction in a language different from that spoken at home. This age group is much more likely to spend their time watching television than studying. Overall, science achievement is positively related to the number of books in the home in each population. There is also a positive relationship between leisure reading and science achievement in the majority of populations.

The gender information provides some interesting differences for 13-year-old males and females in Alberta. Approximately 50% of females feel they are good at science compared with approximately 70% of males. A significantly lower percentage of females feel science is useful in their daily lives; however, there is only a 1% difference between male and female responses to the question "Science is more for boys than girls." Obviously, gender differences continue to exist in science. Performance levels show that females continue to perform at lower levels than males.

Only 19% of Alberta students agreed with the statement "Facts and ideas about science cannot be questioned or changed." This is much lower than the overall average and perhaps is a result of Alberta students conducting experiments more often. Having a questioning attitude is a goal that is supported through Alberta's science education programs.

Information about countries and their education systems provides an important context for understanding the relative performance of participants. Performance levels do not seem to be linked directly to class size, as noted from the high performance of students in Korea and Taiwan and the low performance of some participants with relatively lower class sizes.

Although some consistent relationships between certain background characteristics and achievement can be noted, they do not occur often. Factors that impact on academic performance interact in complex ways and appear to operate differently in different cultures and education systems.

Science Performance of 13-Year-Old Students

Figure 3.1 shows the overall results for all participating populations. It reports science performance for males and females as well as average scores for performance on science topics and cognitive processes. Below is a brief description of each topic and cognitive process:

Life Sciences: Students are able to classify plants and animals, know forms of animal adaption, know the basis of animal behavior, and understand interaction/interdependence within ecosystems.

Physical Sciences: Students know and understand concepts such as time, matter, and energy.

Earth and Space Sciences: Students demonstrate knowledge and understanding of concepts such as the solar system, the universe, and the water cycle.

Nature of Science: Students know and can use scientific inquiry skills. Highlighted in the IAEP were observing, classifying and inferring, interpreting data, and conducting inquiries.

Knows (Knowledge): Students have a knowledge base to solve simple problems.

Uses: Students use factual knowledge and apply basic scientific facts and principles in one or two-step processes.

Integrates: Students can bring together a variety of knowledge and skills to solve more complex problems.

Figure 3.1. Science, Age 13: Distribution of Percent Correct Scores by Country/Province

	Overall Average Percent Correct	Average Male/ Female Percent	Science Topics (%)				Cognitive Processes (%)		
			Life Sciences	Physical Sciences	Earth/ Space Sciences	Nature of Science	Knows	Uses	Integrates
Rank Order/IAEP Average	67		68	64	67	71	73	66	65
Korea	78	80/75	82/78	78/73	78/71	80/78	86/82	80/74	74/71
Taiwan	76	76/75	79/77	75/74	75/69	75/77	82/81	76/73	72/73
Switzerland	74	76/71	76/73	74/66	78/71	80/79	79/75	76/68	76/73
Hungary	73	76/71	79/76	73/67	76/69	75/76	85/80	74/68	70/70
Soviet Union	71	73/70	73/73	74/68	76/70	68/68	79/78	72/67	69/67
Slovenia	70	73/68	75/72	71/64	73/67	72/73	82/78	71/65	67/66
Emilia-Romagna, Italy	70	72/68	73/70	71/63	74/68	73/73	82/78	71/65	67/66
Israel	70	72/68	68/63	72/68	71/65	78/79	73/69	71/66	71/71
Canada	69	71/67	70/67	68/62	71/65	78/80	74/70	69/63	71/71
France	69	71/67	69/66	70/64	70/64	76/76	75/70	68/62	66/65
Scotland	68	70/66	69/66	68/64	68/61	76/77	74/71	69/63	68/68
Spain	68	69/66	72/69	66/62	72/66	70/70	78/75	68/63	64/65
United States	67	69/65	72/67	65/58	70/64	76/76	75/70	68/62	66/65
Ireland	63	66/61	63/59	64/58	70/62	73/70	68/64	66/59	65/62
Jordan	57	57/56	59/58	54/53	62/58	55/57	66/65	58/55	49/50
Special Populations									
China[1]	67	69/65	66/61	70/65	73/68	70/69	71/65	70/64	68/65
England[1]	69	70/67	69/67	69/64	69/63	76/77	74/71	69/64	69/69
Portugal[1]	63	65/60	68/64	62/55	65/58	69/67	72/68	64/58	61/58
Sao Paulo, Brazil[1]	53	56/50	59/54	53/46	62/51	55/51	65/57	56/49	50/45
Fortaleza, Brazil[1]	46	49/44	54/49	45/41	53/46	46/44	59/53	48/44	43/39

[1] This country drew its sample from less than its total student population.

Figure 3.1 (continued). Science, Age 13: Distribution of Percent Correct Scores by Country/Province

	Overall Average Percent Correct	Average Male/ Female Percent	Science Topics (%)				Cognitive Processes (%)		
			Life Sciences	Physical Sciences	Earth/ Space Sciences	Nature of Science	Knows	Uses	Integrates
Canadian Populations/IAEP Average			68	64	67	71	73	66	65
Alberta	74	76/72	74/71	74/68	77/70	85/84	78/74	75/69	77/75
British Columbia	72	74/71	70/70	73/68	74/70	80/82	77/76	72/67	73/75
Manitoba - English	69	70/67	70/66	68/63	74/67	76/78	74/71	69/63	72/70
Manitoba - French	67	70/64	68/63	68/61	72/64	74/73	73/67	68/61	69/68
New Brunswick - English	66	68/65	68/65	65/61	69/63	74/76	71/69	68/62	66/67
New Brunswick - French	64	64/63	63/61	63/61	66/64	67/71	65/62	65/62	62/66
Newfoundland	66	69/64	67/62	66/59	72/66	75/75	73/67	68/61	66/65
Nova Scotia	69	70/67	70/66	68/63	71/66	75/78	74/70	70/65	67/69
Ontario - English	67	69/66	68/65	66/61	68/63	77/80	72/68	67/62	69/70
Ontario - French	60	62/59	62/59	59/54	64/58	68/68	64/60	61/56	62/61
Quebec - English	69	71/67	70/68	68/61	71/65	80/81	74/71	69/63	72/70
Quebec - French	71	73/70	74/71	70/64	73/67	80/80	76/72	72/66	73/74
Saskatchewan - English	70	72/68	72/69	68/62	74/69	79/80	76/72	71/65	70/70
Saskatchewan - French	65	66/63	66/62	62/58	71/67	74/75	69/66	65/59	66/68

Observations (Figure 3.1)

The results are presented for four content areas—Life Sciences, Physical Sciences, Earth and Space Sciences, and Nature of Science—and for three levels of cognitive processing—Knows Science, Uses Science, and Integrates Science. Alberta students performed very well in all areas, especially in Nature of Science. Also of note is Alberta's performance in Integrates Science, which is the highest of all project participants.

Finally, results show that significant differences between male and female performance levels continue to exist. A gender difference is evident in all participating populations, with males consistently outperforming females. The smallest gender differences are found in New Brunswick (French), Taiwan, and Jordan. In Alberta, boys scored on average four percentage points higher than girls. An exception to this trend is found in the results for Nature of Science. But for Alberta and Manitoba (French), all Canadian populations show girls scoring equal to or higher than boys in this content area. Similar results are evident in 13 of the participating countries. These results demonstrate that gaps continue to exist between male and female performance levels in spite of the special attention afforded this issue over the years.

Curriculum Emphasis

Figure 3.2 examines the percentage of schools reporting to emphasize on sub-topics in the four content areas.

Figure 3.2. Science, Age 13: Emphasis for All Major Topics*

	Average Percent Correct	Percent of Schools Reporting to Emphasize:												
		Life Sciences			Physical Sciences					Earth & Space Sciences			Nature of Science	
		Plants	Animals	Human Body	Electricity & Magnatism	Mass Motion & Gravity	Chem Substances	Light & Sound	Solids, Liquids, & Gases	Rocks & Minerals	Weather & Climate	Stars & Planets	Scientific Processes	How to Design Experiments
Populations														
Canada	69	21	19	11	17	32	18	9	51	33	26	16	79	65
Alberta	74	26	8	4	7	15	4	4	33	67	30	26	68	48
British Columbia	72	4	10	31	6	24	17	37	83	36	12	10	71	22
Manitoba-English	69	18	21	62	21	16	34	11	40	32	12	29	62	58
Manitoba-French	67	44	44	56	40	29	47	27	71	20	20	49	78	59
N. Bruns.-English	66	33	43	3	46	14	42	8	34	15	11	5	60	34
N. Bruns.-Fr.	64	24	27	0	6	26	16	3	66	0	3	0	60	49
Nfld.	66	6	27	48	42	2	10	1	46	28	3	0	67	58
Nova Scotia	69	20	38	1	55	27	55	2	18	51	12	5	77	55
Ontario-English	67	27	25	3	21	45	19	8	55	7	9	8	92	85
Ontario-Fr.	60	47	31	16	30	69	34	19	71	6	28	3	94	88
Quebec-English	69	6	5	5	2	13	11	9	60	68	71	5	84	39
Quebec-Fr.	71	6	6	2	6	27	6	4	83	77	91	16	79	60
Sask.-Engl.	70	10	9	5	4	13	4	3	10	73	58	55	52	37
Sask.-Fr.	65	11	19	12	21	34	10	21	17	79	45	72	64	52
Other Interesting Comparisons														
China	67	19	79	11	14	62	5	15	27	8	38	10	22	18
Hungary	73	66	74	74	80	15	24	3	32	31	70	6	44	33
Jordan	57	31	14	29	74	51	62	10	13	20	78	59	16	19
Korea	78	47	64	64	84	10	11	2	19	71	13	5	19	30
Soviet Union	71	47	95	28	70	32	87	35	63	36	73	9	58	44
Switzerland	74	36	38	54	16	17	7	7	10	2	25	10	23	10
Taiwan	76	15	18	11	11	81	20	7	56	1	3	3	61	22
United States	67	25	25	23	19	40	23	20	39	57	54	52	63	56

* School Questionnaire; information for other countries is reported in *Learning Science:* IAEP II

Observations (Figure 3.2)

There is a substantial variation in what sub-topics are emphasized for the different populations. These differences in emphasis from topic to topic cannot always be consistently related to performance. There are some general trends. For example, Hungary reports a high emphasis on Life Sciences sub-topics and shows high performance scores in this area. Alberta's lower performance corresponds to a lower emphasis on Life Science sub-topics.

The emphasis on the Physical Sciences sub-topics varies considerably from population to population. In Korea and Hungary, for example, a high percentage of schools report emphasis on Electricity and Magnetism, whereas British Columbia and Quebec (French) show a high percentage of schools reporting emphasis on Solids, Liquids and Gases. No consistent pattern emerges when comparing emphasis and performance on the Physical Sciences questions. Manitoba (French) and Ontario (French) both report a relatively high emphasis on the Physical Sciences sub-topics, and yet both populations scored lower on this content area when compared with their overall performance scores. Alberta schools reported a lower emphasis on the Physical Sciences sub-topics compared with the Canadian average, and yet Alberta students scored higher than the Canadian average in Physical Sciences.

As with the other content areas, the patterns are not consistent for Earth and Space Sciences, although some general trends do emerge. For example, Taiwan stands out in the very low emphasis reported for Earth and Space Sciences sub-topics and scored 72% on this content area compared with an overall performance score of 76%. Alberta reported a higher percentage of schools emphasizing this sub-topic compared with the Canadian average and scored 74%, only 1% behind top-performing Korea.

Alberta reported a lower percentage of schools emphasizing Nature of Science sub-topics compared with the Canadian average. Yet Alberta students scored 84% on this content area—ranking first overall. The Nature of Science questions compare favorably with Alberta's "process skill" approach in the teaching of science. The low curriculum emphasis reported by schools may not have reflected this aspect of curriculum emphasis. High performance in science would seem to be related to factors other than just curricular emphasis in schools.

Classroom Characteristics

The information reported in this section was collected from students and school administrators. It highlights the variation in teaching practices and classroom factors across various populations.

Figure 3.3. Science, Age 13: Teaching Practices and Average Percent Correct

	Average Percent Correct	Average Minutes of Science Instruction Each Week**	Percent of Students Who:			
			Listen to Science Lessons Each Day*	Never Do Experiments on Their Own*	Take a Science Test or Quiz at Least Once a Week*	Spend 4 Hrs or More on Science Homework Each Week*
Populations						
Canada	69	156	21	13	26	4
Alberta	74	194	44	14	24	6
British Columbia	72	188	29	14	33	7
Manitoba - English	69	201	45	23	27	4
Manitoba - French	67	205	19	10	55	7
N. Bruns. - English	66	180	37	24	27	3
N. Bruns. - French	64	180	24	14	44	4
Newfoundland	66	198	38	13	17	7
Nova Scotia	69	204	47	18	19	6
Ontario - English	67	123	22	14	14	3
Ontario - French	60	141	14	5	38	4
Quebec - English	69	178	36	21	34	6
Quebec - French	71	176	12	10	51	4
Sask. - English	70	166	22	34	14	3
Sask. - French	65	133	14	12	30	4
Other Interesting Comparisons						
China	67	331	23	29	42	16
Hungary	73	207	40	31	27	13
Jordan	57	180	60	26	73	12
Korea	78	144	21	35	21	9
Soviet Union	71	387	80	13	88	59
Switzerland	74	152	28	36	18	1
Taiwan	76	245	25	25	67	10
United States	67	233	66	25	69	7

* Student Questionnaire
** School Questionnaire

Observations (Figure 3.3)

Alberta and British Columbia, the two top-performing provinces, spend more time on science instruction each week compared with the Canadian average. The majority of populations report an average of 150 to 200 minutes spent on science instruction each week. The average is higher in Taiwan, Hungary, and the United States (between 200 and 250 minutes each week), and very high in China and the Soviet Union (between 330 and 390 minutes each week). Korea, Saskatchewan (French), Ontario (French), and Ontario (English) show a relatively shorter length of time spent on science instruction (less than 145 minutes each week).

The United States, Jordan, and especially the Soviet Union all report a relatively high percentage of students who spend their instructional time listening to their teachers explain science lessons every day. Nova Scotia, Manitoba (English), and Alberta are well above the Canadian average for the number of students reporting that they listen to science lessons daily.

Taking tests and quizzes at least once a week is common in some places. The results from the Soviet Union and Taiwan (both high-performing populations) and Jordan and the United States (both lower performing populations) indicate that weekly quizzes are used extensively to evaluate student performance in science. The relationship between frequent testing and overall performance is not consistent for the school-administered or teacher-administered tests that were reported in this study. In general, most populations do not report a majority of schools administering science tests on a weekly basis.

A consistent relationship between the amount of time spent on homework and science achievement is not evident. The majority of students from most populations spend between 0 and 1 hour on science homework each week. The Soviet Union is an exception, with 59% of students reporting that they spend four hours or more on science homework each week.

The information about teaching practices and the relationship to science achievement is examined in Figure 3.4.

Figure 3.4. Science, Age 13: Relationship of Teaching Practices and Average Percent Correct Within Populations

	Amount of Listening to Science Lessons*	Amount of Student Conducted Experiments*	Amount of Science Testing*	Amount of Time Spent on Science Homework*
Populations				
Canada	0	+	+	0
Alberta	+	0	0	0
British Columbia	+	0	+	0
Manitoba - English	+	-	0	0
Manitoba - French	-	-	0	-
N. Bruns. - English	+	-	0	0
N. Bruns. - French	0	-	0	-
Newfoundland	+	0	-	0
Nova Scotia	+	0	-	0
Ontario - English	+	0	0	0
Ontario - French	-	0	0	0
Quebec - English	+	+	0	+
Quebec - French	-	+	+	0
Sask. - English	+	0	0	0
Sask. - French	-	0	0	0
Other Interesting Comparisons				
China	+	0	0	0
Hungary	0	-	0	+
Jordan	+	-	0	0
Korea	+	-	-	-
Soviet Union	+	0	+	+
Switzerland	0	0	0	-
Taiwan	+	0	+	+
United States	0	-	0	0

* Student Questionnaire
+ Statistically significant positive relationship
- Statistically significant negative relationship
0 No statistically significant linear relationship

IAEP II results indicate that science instruction with frequent teacher presentations is positively associated with performance. Canada is the only population where students using hands-on activities was positively related to science performance.

The use of computers and hands-on activities, such as work in science laboratories, is increasingly being advocated by science educators as a central part of learning and developing scientific skills. The information reported in Figure 3.5 shows that access to laboratories and computers varies from country to country.

Figure 3.5. Science, Age 13: Teaching Materials and Average Percent Correct

	Average Percent Correct	Percent of Schools With No Science Laboratories**	Percent of Schools With General or Specialized Science Labs in One or More Classrooms**	Average Number of Computers in School**
Populations				
Canada	69	25	62	17
Alberta	74	2	88	26
British Columbia	72	4	96	37
Manitoba - English	69	9	77	15
Manitoba - French	67	5	90	18
N. Bruns. - English	66	24	68	13
N. Bruns. - French	64	8	71	8
Newfoundland	66	7	83	7
Nova Scotia	69	9	75	12
Ontario - English	67	47	37	15
Ontario - French	60	15	49	14
Quebec - English	69	18	81	15
Quebec - French	71	0	85	18
Sask. - English	70	11	81	14
Sask. - French	65	13	52	10
Other Interesting Comparisons				
China	67	31	68	2
Hungary	73	32	34	6
Jordan	57	22	65	1
Korea	78	0	87	15
Soviet Union	71	3	94	2
Switzerland	74	45	48	4
Taiwan	76	1	99	15
United States	67	14	76	24

** School Questionnaire

Observations (Figure 3.4 and 3.5)

The relationship between the variables examined and achievement are is consistent across the participating countries. Some students have fewer opportunities to conduct experiments as access to laboratories varies significantly from population to population. Still, the majority of schools in most populations indicate that students have access to a general or specialized laboratory.

Few schools in the Canadian provinces are without the benefit of having a lab. Ontario (English) is an exception, with almost one-half of schools reporting that they do not have a science laboratory. Although Korea and Taiwan report almost universal access to labs, both countries have a relatively high percentage of students reporting that they never do experiments (see Figure 3.3). Perhaps this is a result of the large class sizes. Alberta has the lowest percentage of schools in Canada that report not having a science laboratory—2% compared to the Canadian average of 25%. The commitment in Alberta to the development of science process skills through hands-on experimentation seems to be supported through facilities that include laboratories for student use.

Access to computers also varies vastly among the participants. Very few populations indicate that they have enough computers that would allow students to use them for school work. Alberta, the United States, and British Columbia report having from 24 to 37 computers in each school that students can use for school work. This is high compared to other participants in the study.

Figure 3.6 reports information on the academic background of the teachers responsible for teaching science. It also shows the percentage of schools that report assigning students to science classes based on ability.

Figure 3.6. Science, Age 13: Teacher Background, Classroom Organization, and Average Percent Correct

	Average Percent Correct	Percent of Schools Where:		
		Teacher Teaches Science Most or All the Time**	All Science Teachers Have Taken Some Post-Secondary Science Courses**	Science Classes Are Based on Ability**
Populations				
Canada	69	37	50	5
Alberta	74	51	66	0
British Columbia	72	78	84	8
Manitoba - English	69	45	65	1
Manitoba - French	67	47	51	0
N. Bruns. - English	66	28	38	0
N. Bruns. - French	64	21	52	18
Newfoundland	66	49	61	2
Nova Scotia	69	77	60	8
Ontario - English	67	21	40	2
Ontario - French	60	9	10	6
Quebec - English	69	61	86	7
Quebec - French	71	81	49	21
Sask. - English	70	19	58	4
Sask. - French	65	14	43	17
Other Interesting Comparisons				
China	67	74	28	1
Hungary	73	59	79	0
Jordan	57	87	72	10
Korea	78	89	10	1
Soviet Union	71	85	66	13
Switzerland	74	29	25	17
Taiwan	76	100	38	57
United States	67	79	62	29

** School Questionnaire

Observations (Figure 3.6)

In Canada, teachers of science also teach other courses of study more often than science teachers in other countries do. It is also interesting to note that in Korea and Ontario (French), only 10% of teachers teaching science have taken post-secondary science courses. The Canadian provinces report large differences in their responses. Quebec (English) and British Columbia report the highest percentage of science teachers with post-secondary courses in science. Taiwan reports that 100% of teachers teach science most or all of the time. Approximately one-half of Alberta schools use specialists to teach science, and over 65% of those teaching science have taken some post-secondary training in science.

Only Taiwan reports a high percentage of schools that organize science classes on the basis of ability. Alberta schools report that they never do this. The highest achieving populations, with the exception of Taiwan, do not assign students to science classes on the basis of ability.

Students and Their Homes

The IAEP study collected descriptive information about the students themselves and their families. Figures 3.7, 3.8, 3.9, and 3.10 report this information.

Figure 3.7. Science, Age 13: Home Characteristics* and Average Percent Correct

	Average Percent Correct	Percent of Students Who:					
		Speak the Same Language at Home as at School	Have 4 or More Brothers and Sisters	Have Fewer than 25 Books at Home	Have Parents Who are Interested in Science	Talk with Someone at Home about Science Class	Receive Help at Home with Science Homework
Populations							
Canada	69	88	7	14	36	47	47
Alberta	74	91	11	11	39	52	59
British Columbia	72	88	9	9	39	57	56
Manitoba - English	69	89	10	12	33	44	47
Manitoba - French	67	19	9	15	33	50	42
N. Bruns. - English	66	96	10	14	34	44	51
N. Bruns. - French	64	89	7	31	28	45	49
Newfoundland	66	98	11	18	39	53	62
Nova Scotia	69	98	9	12	39	48	60
Ontario - English	67	86	8	10	38	45	50
Ontario - French	60	52	5	26	36	44	49
Quebec - English	69	79	7	7	41	46	38
Quebec - French	71	92	5	21	31	47	40
Sask. - English	70	95	11	12	34	43	51
Sask. - French	65	11	12	12	37	53	52
Other Interesting Comparisons							
China	67	97	12	30	62	80	40
Hungary	73	99	3	10	54	75	61
Jordan	57	98	88	48	55	79	40
Korea	78	98	21	25	28	53	44
Soviet Union	71	87	11	11	31	67	26
Switzerland	74	79	4	16	49	54	26
Taiwan	76	N/A	12	35	19	59	45
United States	67	94	15	18	35	50	53

*Student Questionnaire

Figure 3.8. Science, Age 13: Relationship of Home Characteristics and Average Percent Correct Within Populations

	Number of Brothers and Sisters*	Number of Books in the Home*	Parents are Interested in Science*
Populations			
Canada	-	+	+
Alberta	0	+	+
British Columbia	-	+	+
Manitoba - English	-	+	+
Manitoba - French	0	+	+
N. Bruns. - English	-	+	+
N. Bruns. - French	-	+	+
Newfoundland	-	+	+
Nova Scotia	0	+	+
Ontario - English	-	+	+
Ontario - French	0	+	+
Quebec - English	-	+	+
Quebec - French	0	+	+
Sask. - English	-	+	+
Sask. - French	0	+	+
Other Interesting Comparisons			
China	-	+	0
Hungary	-	+	0
Jordan	0	+	0
Korea	-	+	+
Soviet Union	-	+	0
Switzerland	-	+	0
Taiwan	0	+	0
United States	-	+	+

* Student Questionnaire
+ Statistically significant positive relationship
- Statistically significant negative relationship
0 No statistically significant linear relationship

Observations (Figure 3.7 and 3.8)

More than 12% of students living in Canada, Switzerland, and the Soviet Union report that they receive instruction at school in a language different from the one spoken at home. In Saskatchewan (French), almost 90% of students report that a different language from the one used in school was spoken at home.

Family size is generally smallest in industrialized nations. For example, only 7% of 13-year-olds in Canada report that they have four or more brothers and sisters. In Jordan, 88% of students indicate that they come from families where there are four or more children. In general, science performance is higher for students from smaller families.

The role of language and the opportunity to read by having material at home is important in learning and is positively related to performance in science (Figures 3.7 and 3.8). In Alberta, parental interest in science is also positively linked to student performance in science. In this case, a North American cultural effect exists which is not generally consistent in other countries. With the exception of North America and Korea (Figure 3.8), a significant relationship between parental interest in science and student achievement does not exist.

Figures in 3.9 and 3.10 examine some out-of-school activities that may be related to science achievement.

Figure 3.9. Science, Age 13: Home Activities* and Average Percent Correct

	Average Percent Correct	Percent of Students Who:			
		Read for Fun Almost Every Day	Spend 2 Hrs or More on all Homework Every Day	Watch Television 5 Hrs or More Every Day	Have Positive Attitudes Toward Science**
Populations					
Canada	69	36	26	15	62
Alberta	74	37	20	14	62
British Columbia	72	38	27	13	60
Manitoba - English	69	37	16	19	55
Manitoba - French	67	43	21	14	58
N. Bruns. - English	66	38	19	22	56
N. Bruns. - French	64	28	19	16	63
Newfoundland	66	39	27	23	67
Nova Scotia	69	36	20	22	59
Ontario - English	67	37	27	17	62
Ontario - French	60	33	22	18	71
Quebec - English	69	40	33	15	56
Quebec - French	71	32	25	12	61
Sask. - English	70	36	13	17	55
Sask. - French	65	45	17	10	57
Other Interesting Comparisons					
China	67	28	35	2	74
Hungary	73	44	61	16	69
Jordan	57	22	54	10	82
Korea	78	11	38	10	27
Soviet Union	71	48	52	19	66
Switzerland	74	49	21	7	59
Taiwan	76	17	44	7	51
United States	67	29	31	22	57

* Student Questionnaire

** Students were asked to what extent they agreed with the following statements: Much of what is learned in science is useful in everyday life; It is important to know some science to get a good job; I am good at science; My parents are interested in science. Their responses were combined to form an index of attitudes toward science.

Figure 3.10. Science, Age 13: Relationship of Home Activities and Average Percent Correct Within Populations

	Amount of Leisure Reading*	Amount of Time Spent on All Homework*	Amount of Time Spent Watching Television*	Students' Attitudes Toward Science*
Populations				
Canada	+	-	-	+
Alberta	+	-	-	+
British Columbia	+	0	-	+
Manitoba - English	+	-	-	+
Manitoba - French	+	-	-	+
N. Bruns. - English	+	-	-	+
N. Bruns. - French	+	-	-	+
Newfoundland	+	-	0	+
Nova Scotia	+	0	-	+
Ontario - English	+	-	-	+
Ontario - French	+	-	-	+
Quebec - English	+	0	-	+
Quebec - French	+	0	-	+
Sask. - English	+	-	-	+
Sask. - French	0	0	0	+
Other Interesting Comparisons				
China	+	0	-	+
Hungary	+	+	-	+
Jordan	0	+	0	+
Korea	+	0	-	+
Soviet Union	+	+	0	0
Switzerland	+	0	-	+
Taiwan	+	+	-	+
United States	+	0	-	+

* Student Questionnaire
+ Statistically significant positive relationship
- Statistically significant negative relationship
0 No statistically significant linear relationship

Observations (Figures 3.9 and 3.10)

How students spend their time outside of school hours provides interesting information and comparisons. Consistent reading is positively related to achievement in the majority of populations; however, the lowest percentage of daily readers reported was in Korea (11%) and Taiwan (17%), two countries that achieved the highest overall science scores. Alberta reports that 37% of their 13-year-olds read for fun almost every day.

In Canada, many provinces showed a negative relationship between time spent on all homework and science achievement. All other participating populations show either no relationship or a positive one. In Jordan, Hungary, and the Soviet Union, a higher percentage of students report that they spend two hours or more on all homework every day. Generally, students in Canada and Switzerland report spending the least time overall on homework. In Alberta, students who spend the most time doing homework perform at lower levels.

The amount of time students spend watching television is related to performance. With very few exceptions, the more television students watch the lower their performance scores. In the United States, slightly more than one-fifth of 13-year-olds report watching five hours or more of television every day compared to 14% of Alberta students.

Finally, a positive attitude toward science is likely to result in better performance. This trend existed for nearly all populations.

Figure 3.11 probes students attitude toward science. The percentage of males and females agreeing with the statements is reported for Alberta's students.

Figure 3.11. Science, Age 13: Attitudes Towards Science* and Average Percent Correct

	Average Percent Correct	Percent of Students Agreeing With Statement:				
		I am Good At Science.	Science is More for Boys than Girls.	What I Learn in Science is Useful in Everyday Life.	It is Important to Know Some Science to Get a Good Job.	Facts & Ideas About Science Cannot be Questioned or Changed.
Populations						
Canada	69	65	3	57	76	26
Alberta**	74 76/72	60 69/51	5 5/4	55 60/51	83 85/81	19 23/15
British Columbia	72	57	5	51	82	18
Manitoba - English	69	55	6	47	79	21
Manitoba - French	67	72	4	53	69	39
N. Bruns. - Engl.	66	55	4	53	79	26
N. Bruns. - French	64	69	4	66	71	41
Newfoundland	66	58	5	63	88	25
Nova Scotia	69	55	4	54	86	25
Ontario - English	67	63	4	54	83	25
Ontario - French	60	78	4	68	79	42
Quebec - English	69	55	4	48	70	26
Quebec - French	71	72	2	65	58	33
Sask. - English	70	56	5	46	80	23
Sask. - French	65	71	5	54	71	36
Other Interesting Comparisons						
China	69	46	0	81	71	46
Hungary	73	39	4	79	72	57
Jordan	57	84	18	89	79	64
Korea	78	25	32	61	35	36
Soviet Union	71	40	14	70	82	22
Switzerland	74	49	4	73	45	41
Taiwan	76	19	20	77	70	34
United States	67	62	7	52	77	21

* Student Questionnaire
** Male/Female percentages

Observations (Figure 3.11)

Having a positive attitude toward science is positively related to science achievement in the majority of populations. In some cases, though, strong beliefs about being good at science did not relate to higher performance. In Ontario (French), for example, almost 80% of students feel they are good at science. In Taiwan and Korea, both high performers, only 19% and 25% respectively perceived themselves as being good at science. Alberta students responded in a manner similar to most other students in Canada, with slightly more than half of them indicating they believe they are good in science.

The majority of students feel that what they learn in science is useful in their everyday life. Curiously, North American students were less likely to see science as being useful. The majority of students report that it is important to know some science to get a good job. Korea and Switzerland are the exceptions; only 35% of Korean 13-year-olds and 45% of Swiss students feel that they need some science to get a good job. Students in Alberta believe science is important.

Alberta's results indicate that our students have a healthy, questioning attitude; only 19% of students feel that they cannot question or change science facts and ideas. The curriculum in Alberta encourages students to question ideas and to apply scientific skills in order to understand the world they live in. In Alberta, 85% of females feel they can question science ideas compared to 77% of males. British Columbia, the Soviet Union, and the United States display similar results. A majority of students in Hungary and Jordan feel science ideas are not to be questioned.

SECTION 4: MATHEMATICS RESULTS

The information in this section shows the results for mathematics. In Alberta 1422 students were sampled to write the mathematics portion of the study and to answer related background questions.

The information is displayed according to categories that were used in the overall study report: mathematics performance of 13-year-olds, curriculum-related information, classroom characteristics, students and their homes, and education systems.

Summary of Mathematics Information

This study provides information on the context for learning mathematics. Alberta's 13-year-old students report that they spend 0 to 1 hour on mathematics homework each week, do not have weekly mathematics quizzes, listen to mathematics lessons approximately 60% of the time, and seldom or never use mathematics tools, but they do use calculators and computers.

In Alberta, mathematics classes are not based on ability. As well, about one-half of students report completing exercises on their own every day and slightly over one-third work in small groups to solve problems at least once a week. Slightly more than one-half of the teachers teaching mathematics to 13-year-olds are specialists.

It is interesting to note that although China, Korea, and Taiwan report a very high percentage of specialists teaching mathematics, a relatively low percentage of teachers have post-secondary courses in mathematics. An interesting research question would be the amount of inservice training in instructing mathematics that these teachers are receiving.

Alberta's performance in mathematics varied; Alberta students performed well in some areas and not so well in others. One area where Alberta students did do well was in, "Data Analysis, Probability, and Statistics." The two areas that Alberta performed lowest in were "Geometry" and "Algebra and Functions."

Fifteen percent of the assessment was devoted to Geometry. Four questions dealt directly with knowing the measures of an angle when given other information to permit calculations. Alberta students performed poorly when calculating the measure of an angle from supplementary angles, the angles of a triangle, or in right angles. According to the Alberta programs of study, students should know how to do these calculations.

In Algebra and Functions, students were required to express relationships in equations, to substitute numbers for variables, and to solve equations for one variable. According to Alberta's programs of study, students should be able to solve expressions such as [16+3y, y=-2], [2x+4=10, solve for x], and [n(n+2), when n=4]. Alberta's performance was well below the performance levels of most other participants in the study. Students were able to match algebraic expressions to written statements, showing that Alberta students have a good conceptual understanding of writing number sentences. Many top-performing countries, with the exception of Switzerland, tend to place a heavy emphasis on algebra at this age.

Finally, there is room for improvement in certain areas of mathematics. This study clearly points out at least two areas where performance was below what was expected: "Geometry" and "Algebra and Functions."

Mathematics Performance of 13-Year-Old Students

Figure 7 shows the overall results for participating populations. It reports mathematics performance for males and females, as well as average scores for performance on mathematics topics and cognitive processes. Below is a brief description of each topic and cognitive process.

Numbers and Operations: Students show they know numbers, can compute (+, -, x, ÷), and can apply ratios and percentages.

Measurement: Students show they know and can use measurements of length, time, money, temperature, mass/weight, area, and angles.

Geometry: Students show they can describe, compare, and classify geometric figures; visualize, draw, and construct geometric figures; and apply this knowledge in solving problems.

Data Analysis, Probability, and Statistics: Students show they can read, interpret, and make predictions using tables and graphs, and they can calculate averages and create graphs (bar, line, etc.)

Algebra and Functions: Students can write symbolic expressions and verbal statements (e.g., number sentences with one or two variables), solve simple equations (e.g. y=x+2, find y when x is 9, etc.), and solve problems that require setting up equations and solving for one variable.

Conceptual Understanding: Students show an understanding of mathematics principles (e.g., division), and can recognize, interpret, and apply the signs, symbols, and terms used in mathematics.

Procedural Knowledge: Students know what to do to solve a problem and can use basic knowledge and skills to complete tasks.

Problem Solving: Students show skill in using reasoning and analytic abilities, and can judge the reasonableness of answers.

Figure 4.1 shows the overall results for all populations.

Figure 4.1. Mathematics, Age 13: Distribution of Percent Correct Scores by Country/Province

	Overall Average Percent Correct	Average Male/ Female Percent	Topics (%)					Cognitive Processes (%)		
			Num. & Oper.	Meas.	Geo-metry	Data Anal./ Prob./ Stats.	Algebra/ Func.	Concept Underst.	Proced. Know.	Problem Solving
Rank Order/IAEP Average	58		61	47	62	69	54	61	58	56
Korea	73	74/72	77	60	77	81	71	78	73	68
Taiwan	73	73/72	75	64	77	81	69	75	75	69
Switzerland	71	73/69	74	62	77	82	63	72	69	72
Soviet Union	70	70/70	69	60	78	76	72	70	73	67
Hungary	68	68/68	69	55	73	76	70	68	71	64
France	64	66/63	65	53	73	79	57	67	66	59
Emilia-Romagna, Italy	64	66/62	64	63	75	72	53	67	62	63
Israel	63	64/62	65	47	66	75	65	64	65	60
Canada	62	63/61	66	50	68	76	53	65	62	59
Scotland	61	60/61	60	51	70	79	53	62	62	58
Ireland	61	63/58	65	49	60	72	56	62	59	61
Slovenia	57	58/56	62	43	63	64	52	58	59	54
Spain	55	57/54	60	38	60	68	52	58	56	52
United States	55	56/55	61	40	54	72	49	57	56	52
Jordan	40	41/39	43	32	44	46	38	45	38	38
Special Populations										
China	80	82/79	85	71	80	75	82	82	83	76
England	61	61/60	59	51	70	80	54	62	59	61
Portugal	48	50/48	52	32	49	69	43	52	47	46
Sao Paulo, Brazil	37	38/36	41	24	34	50	36	38	36	36
Fortaleza, Brazil	32	35/30	36	20	29	44	32	35	31	31
Maputo & Beira, Mozambique	28	29/28	34	20	29	35	20	34	23	28

Figure 4.1, continued. Mathematics, Age 13: Distribution of Percent Correct Scores by Country/Province

	Overall Average Percent Correct	Average Male/ Female Percent	Topics (%)					Cognitive Processes (%)		
			Num. & Oper.	Meas.	Geo-metry	Data Anal./ Prob./ Stats.	Algebra/ Func.	Concept Underst.	Proced. Know.	Problem Solving
Canadian Populations/IAEP Average	58		61	47	62	69	54	61	58	56
Quebec - French	69	70/68	72	56	78	81	58	73	68	65
Saskatchewan - French	68	70/66	74	54	69	76	62	70	69	63
British Columbia	66	67/65	69	54	70	80	60	69	68	62
Quebec - English	66	66/66	69	54	71	78	60	68	67	62
Alberta	64	64/63	69	54	67	80	52	68	63	61
Manitoba - French	63	64/62	67	49	67	75	59	65	66	58
Saskatchewan - English	62	63/61	66	50	63	78	55	64	64	57
New Brunswick - French	61	60/61	65	47	65	72	54	64	63	55
Nova Scotia	60	61/59	63	47	64	74	54	62	60	57
Newfoundland	59	58/60	62	45	65	72	53	62	60	54
Ontario - English	58	59/57	62	46	63	74	50	61	59	56
Manitoba - English	58	58/58	63	46	58	74	51	61	59	54
New Brunswick - English	58	58/57	62	51	62	71	43	61	55	56
Ontario - French	53	54/54	58	39	59	69	45	57	54	50

Observations (Figure 4.1)

The average score across all populations was 58%. Students in Alberta, with an overall average of 64%, were outperformed by students in Quebec (French and English), British Columbia, and Saskatchewan (French). Alberta's performance is in the middle compared with the performance of other participants; this does not meet the provincial expectation of performance that compares favorably with the best in the world.

The results are presented for five content areas—Numbers and Operations, Measurement; Geometry; Data Analysis, Probability, and Statistics; and Algebra and Functions—and three levels of cognitive processing—Conceptual Understanding, Procedural Knowledge, and Problem Solving. The content area of Measurement received the lowest overall IAEP score, only 47%. Alberta students scored an average of 54% on measurement questions. They did well in most content areas with the exception of Algebra and Functions and some aspects of Geometry. Alberta's results in Algebra and Functions and in Geometry were its lowest of the five content areas assessed.

Curriculum Emphasis

Figure 4.2 examines the percentage of schools reporting to emphasize sub-topics within the content areas.

Figure 4.2. Mathematics, Age 13: Emphasis For All Major Topics*

	Percent of Schools Reporting to Emphasize:											
	Average Percent Correct	Numbers and Operations					Measurement	Geometry	Data Analysis, Probability, & Statistics			Algebra
		Numbers	Fractions	Decimals	Ratios	Percent			Tables/ Graphs	Probability	Statistics	
Populations												
Canada	62	72	52	63	48	57	53	41	18	5	8	41
Alberta	64	72	66	66	69	58	64	34	19	3	9	31
British Columbia	66	67	57	61	43	45	44	38	12	2	4	45
Manitoba - English	58	68	58	73	36	48	47	34	20	3	5	44
Manitoba - French	63	84	73	84	56	58	67	49	27	9	11	64
N. Brunswick - English	58	62	36	48	40	48	58	31	9	0	6	18
N. Brunswick - French	61	92	44	44	49	41	49	48	3	2	3	69
Newfoundland	59	55	36	44	32	42	43	41	11	0	4	18
Nova Scotia	60	64	58	64	58	64	60	36	24	4	14	28
Ontario - English	58	79	47	66	42	61	53	40	18	3	7	39
Ontario - French	53	89	79	92	55	72	72	70	38	10	20	64
Quebec - English	66	37	43	43	36	39	45	44	24	8	10	42
Quebec - French	53	54	44	41	61	58	45	53	16	14	16	90
Saskatchewan - English	62	75	62	70	56	58	53	31	14	4	5	15
Saskatchewan- French	68	66	72	79	79	79	55	38	17	14	14	34
Other Interesting Comparisons												
China	80	23	24	21	20	22	22	80	15	9	9	94
Hungary	68	71	90	88	13	60	32	79	44	0	2	90
Jordan	40	61	21	25	75	61	23	43	6	0	0	59
Korea	73	47	19	30	10	3	15	67	37	53	11	86
Soviet Union	70	46	54	60	27	17	40	83	67	0	3	96
Switzerland	71	75	72	81	43	41	70	58	20	0	0	23
Taiwan	73	33	24	15	52	7	9	14	35	0	15	74
United States	55	49	54	52	38	42	38	27	18	9	13	51

* School Questionnaire

Observations (Figure 4.2)

Patterns of instruction and emphasis on the sub-topics vary from population to population. Most countries still emphasize Numbers and Operations at age 13. Korea, Taiwan, and China are all high-performing populations that do not emphasize the various Numbers and Operations sub-topics as much as other populations do.

Some general patterns are noted in these results. For example, Alberta students scored an average of 54% on Measurement, above the overall IAEP II average of 47%. This correlates with our relatively high emphasis on Measurement. With the exception of Switzerland, the higher performing populations do not emphasize Measurement at this age.

The emphasis on Geometry varies considerably from population to population. China, Hungary, Korea, the Soviet Union, and Ontario (French) report a high emphasis on Geometry. With the exception of Ontario (French), all of these populations performed very well in Geometry. Taiwan does not emphasize Geometry at this age, and yet they performed very well in this area. Alberta schools report a lower emphasis on Geometry (34%) compared with high-performing countries like Hungary (79%).

There is substantial variation in emphasis on the three sub-topics in Data Analysis, Probability, and Statistics. There is heavier emphasis on tables and graphs than on probability or statistics. Korea and, to some extent, Taiwan and Ontario (French) stand out in the higher emphasis reported on this content area. With the exception of China, every population scored higher on this content area compared with their overall performance scores. Although not reporting a high emphasis on this area, Alberta performed at 80% on Data Analysis, Probability, and Statistics.

Alberta schools report a lower emphasis on Algebra compared with other populations. Alberta students scored 52% on Algebra compared with the overall IAEP average of 54%. With the exception of Switzerland, high-performing populations report a high emphasis on Algebra: China 94%, Hungary 90%, Korea 86%, Taiwan 74%, and the Soviet Union 96%. The four Canadian populations that report a higher emphasis on Algebra compared with other Canadian populations are Quebec (French), New Brunswick (French), Manitoba (French), and Ontario (French). These populations did not perform at correspondingly high levels.

Classroom Characteristics

The information reported in this section was collected from students and school administrators. It highlights the variation in teaching practices and classroom factors across various populations.

Figure 4.3. Mathematics, Age 13: Teaching Practices and Average Percent Correct

	Average Percent Correct	Average Minutes of Math Instruction Each Week**	Percent of Students Who:				
			Listen to Math Lessons Each Day*	Do Math Exercises on Their Own Each Day*	Solve Problems in Groups at Least Once a Week*	Take a Math Test or Quiz at Least Once a Week*	Spend 4 Hrs or More on Math Homework Each Week*
Populations							
Canada	62	225	51	50	40	53	15
Alberta	64	214	62	50	41	38	15
British Columbia	66	199	37	34	44	54	12
Manitoba - English	58	216	60	49	42	37	10
Manitoba - French	63	238	16	31	41	59	17
N. Bruns. - English	58	256	63	54	44	41	10
N. Bruns. - French	61	304	26	47	24	48	17
Newfoundland	59	318	76	60	47	23	19
Nova Scotia	60	260	70	55	44	32	14
Ontario - English	58	211	67	55	48	32	16
Ontario - French	54	217	22	32	38	54	14
Quebec - English	66	273	19	40	43	49	14
Quebec - French	69	270	73	62	21	99	15
Sask. - English	62	221	55	44	43	20	11
Sask. - French	68	226	14	38	38	40	16
Other Interesting Comparisons							
China	80	307	74	78	68	63	37
Hungary	68	186	40	37	55	17	11
Jordan	40	180	62	34	83	68	14
Korea	73	179	32	17	28	28	33
Soviet Union	70	258	62	40	54	52	33
Switzerland	71	251	60	47	47	40	15
Taiwan	73	204	64	32	38	87	24
United States	55	228	78	50	49	68	15

* Student Questionnaire
** School Questionnaire

Figure 4.4 presents information about the relationship between teaching practices and mathematics performance.

Figure 4.4. Mathematics, Age 13: Relationship of Teaching Practices and Average Percent Correct Within Populations

	Amount of Listening to Mathematics Lessons*	Amount of Doing Math Exercises on Own*	Amount of Problem Solving in Groups*	Amount of Mathematics Testing*	Amount of Time Spent on Mathematics Homework*
Populations					
Canada	-	+	-	+	0
Alberta	+	+	-	0	0
British Columbia	+	+	-	0	0
Manitoba - English	+	+	-	0	0
Manitoba - French	-	+	0	0	-
N. Bruns. - English	+	+	-	0	0
N. Bruns. - French	-	+	-	0	0
Newfoundland	+	+	-	0	0
Nova Scotia	+	+	-	0	+
Ontario - English	0	+	-	0	0
Ontario - French	-	+	-	+	0
Quebec - English	0	0	0	-	0
Quebec - French	-	+	0	+	0
Sask. - English	0	+	-	0	-
Sask. - French	-	0	0	0	0
Other Interesting Comparisons					
China	+	0	0	0	+
Hungary	+	+	-	-	+
Jordan	+	0	0	-	+
Korea	+	+	-	-	+
Soviet Union	+	+	-	+	+
Switzerland	0	0	-	0	0
Taiwan	+	+	+	+	+
United States	+	+	-	+	+

* Student Questionnaire
\+ Statistically significant positive relationship
\- Statistically significant negative relationship
0 No statistically significant linear relationship

Observations (Figure 4.3 and 4.4)

The different features of educational programs help to describe the learning context in various places. The majority of populations report an average of 200 to 250 minutes being spent on mathematics instruction each week. The average is slightly higher in the Soviet Union and Switzerland and is especially high in China (307 minutes each week). Korea, Hungary, and Jordan show a relatively shorter length of time spent on math instruction (between 179 and 186 minutes each week). Quebec (French and English), Newfoundland, and New Brunswick (French) report the largest amount of time for mathematics instruction; Alberta schools spend on average of 214 minutes on mathematics instruction each week.

Reported classroom activities provide interesting comparisons. For example, 78% of students in China report that they do mathematics exercises on their own every day compared with 62% in Quebec (French) and 50% in Alberta. Independent work is positively related to mathematics achievement in the majority of populations. Also interesting is the negative relationship between solving problems in small groups and achievement. This may be because paper and pencil tests cannot measure important skills that are developed in small-group learning experiences.

The relationship between testing and performance is not consistent. The majority of participants do not use mathematics tests or quizzes on a weekly basis. Thirty-eight percent of Alberta students report taking a math quiz on a weekly basis. Quebec (French) reports regular use of weekly quizzes or tests.

The majority of students spend between 0 and 1 hour on mathematics homework each week. China is an exception, where 37% of students reporting that they spend four hours or more on math homework each week. The Soviet Union, Korea, and Taiwan, where 24% to 33% of students report spending more than four hours on math homework each week, are higher than the norm. Results from China, the Soviet Union, Korea, and Taiwan show a positive relationship between the amount of time spent on mathematics homework and performance. Curiously, Nova Scotia is the only Canadian population where there is a positive relationship between mathematics performance and time spent on mathematics homework. In Alberta, 15% of students report that they spend four hours or more each week on mathematics homework. This was not found to have either a positive or a negative effect on their performance in Mathematics.

The information reported in Figure 4.5 indicates the extent to which manipulatives and new technologies have been integrated into schools.

Figure 4.5. Teaching Materials and Average Percent Correct

	Average Percent Correct	Percent of Students Who:				Average Number of Computers in School**
		Work With Math Tools at Least Once a Week*	Have a Calculator*	Ever Use Calculators in School*	Ever Use Computers for School Work or Homework*	
Populations						
Canada	62	14	91	75	42	17
Alberta	64	13	92	85	52	26
British Columbia	66	11	92	83	51	37
Manitoba - English	58	13	84	53	42	15
Manitoba - French	63	10	88	55	35	18
N. Bruns. - Engl.	58	19	89	87	29	13
N. Bruns. - French	61	12	87	72	11	8
Newfoundland	59	25	93	89	35	7
Nova Scotia	60	18	86	60	41	12
Ontario - English	58	16	91	74	53	15
Ontario - French	54	16	90	75	46	14
Quebec - English	66	20	92	73	16	15
Quebec - French	69	10	92	76	43	18
Sask. - English	62	15	86	67	49	14
Sask. - French	68	13	83	73	40	10
Other Interesting Comparisons						
China	80	40	21	7	6	2
Hungary	68	43	87	71	31	6
Jordan	40	39	53	5	5	1
Korea	73	17	20	4	10	15
Soviet Union	70	32	47	19	6	2
Switzerland	71	36	85	51	25	4
Taiwan	73	38	58	62	6	15
United States	55	18	89	54	37	24

* Student Questionnaire
** School Questionnaire

Observations (Figure 4.5)

The use of math manipulatives, calculators, and computers is not yet a part of mathematics instruction in most populations. Alberta, other Canadian provinces, Korea, and the United States report a relatively low percentage of students that work with concrete mathematics materials. Students in China, Hungary, Jordan, and Taiwan are higher than the norm; approximately 40% of students from these countries indicate working with mathematics tools at least once a week. Overall, results show that most students do not use manipulatives when learning mathematics.

Ownership of calculators is common except in Korea, China and to some extent, the Soviet Union, Taiwan, and Jordan. Although the use of calculators in school is common in Hungary, in the Canadian provinces and, to some extent, in Taiwan, students in most countries report using calculators in school infrequently.

Overall, computer use is even more infrequent than calculator use. The majority of students report that they never use a computer for school work or homework. Alberta, British Columbia, and Ontario (English) are the only places where over one-half of students report using a computer for school work or homework. Very few populations indicate that they have enough computers for students to use on a regular basis for school work. Alberta, British Columbia, and the United States do have this benefit, as they report having from 24 to 37 computers in each school.

Figure 4.6 reports information about teachers and about the percentage of schools reporting to assign students to mathematics classes based on ability.

Figure 4.6. Mathematics, Age 13: Teacher Background, Classroom Organization, and Average Percent Correct

	Average Percent Correct	Percent of Schools Where:		
		Teacher Teaches Math Most or All the Time**	All Math Teachers Have Taken Some Post-Secondary Math Courses**	Math Classes are Based on Ability**
Populations				
Canada	62	31	44	10
Alberta	64	53	58	2
British Columbia	66	58	58	26
Manitoba - English	58	39	46	5
Manitoba - French	63	36	51	0
N. Bruns. - English	58	41	32	3
N. Bruns. - French	61	49	58	19
Newfoundland	59	29	65	6
Nova Scotia	60	78	60	10
Ontario - English	58	7	31	6
Ontario - French	54	10	17	8
Quebec - English	66	64	57	32
Quebec - French	69	98	58	34
Sask. - English	62	19	62	9
Sask. - French	68	7	39	14
Other Interesting Comparisons				
China	80	91	45	3
Hungary	68	53	100	0
Jordan	40	99	81	5
Korea	73	88	12	0
Soviet Union	70	92	79	18
Switzerland	71	25	18	18
Taiwan	73	99	37	63
United States	55	95	76	56

** School Questionnaire

Observations (Figure 4.6)

In Alberta, 53% of teachers who teach 13-year-olds mathematics teach mathematics most or all of the time. China, Korea, the Soviet Union, Taiwan, the United States, and Jordan report that approximately 90% of teachers teaching mathematics teach mathematics most of the time.

In Hungary, mathematics teachers universally have post-secondary courses in mathematics. China, Korea, and Taiwan, other high-performing populations, report a low percentage of teachers with post-secondary courses in mathematics. Alberta and British Columbia results show that more than one-half of teachers teaching mathematics have post-secondary courses. This figure is above the Canadian average.

The highest achieving populations, with the exception of Taiwan, do not group by ability. In British Columbia, 26% of schools report using ability to group students in mathematics classes. In Taiwan, 63% of schools report organizing their mathematics classes on the basis of ability. In Alberta, only 2% of schools report using the practice.

Students and Their Homes

Figures 4.7, 4.8, 4.9, and 4.10 report information about students themselves and their homes. A number of questions examined how students spend some of their time outside of school in ways that may enhance their in-school performance.

Figure 4.7. Mathematics, Age 13: Home Characteristics* and Average Percent Correct

	Average Percent Correct	Percent of Students Who:					
		Speak the Same Language at Home as at School	Have 4 or more Brothers and Sisters	Have Fewer than 25 Books at Home	Have Parents Who Want them to Do Well in Math	Talk with Someone at Home about Math Class	Receive Help at Home with Math Homework
Populations							
Canada	62	88	8	13	96	64	69
Alberta	64	91	10	10	97	63	74
British Columbia	66	89	9	10	95	61	70
Manitoba - English	58	90	11	12	95	54	65
Manitoba - French	63	17	9	14	89	56	60
N. Bruns. - English	58	95	10	13	95	57	66
N. Bruns. - French	61	90	7	31	96	67	65
Newfoundland	59	98	12	17	97	67	73
Nova Scotia	60	98	10	12	97	63	69
Ontario - English	58	87	9	11	97	63	72
Ontario - French	54	55	6	26	95	68	67
Quebec - English	66	92	5	19	95	67	63
Quebec - French	69	76	10	10	97	69	62
Sask. - English	62	95	10	13	95	58	72
Sask. - French	68	12	9	14	89	55	66
Other Interesting Comparisons							
China	80	97	11	26	81	85	37
Hungary	68	99	3	10	93	85	80
Jordan	40	99	88	51	91	79	43
Korea	73	97	19	24	92	52	53
Soviet Union	70	89	13	12	84	61	32
Switzerland	71	80	4	16	85	67	42
Taiwan	73	N/A	12	35	90	74	51
United States	55	94	18	17	96	67	74

* Student Questionnaire

N/A Information is not available.

Figure 4.8. Mathematics, Age 13: Relationship of Home Characteristics and Average Percent Correct Within Populations

	Number of Brothers and Sisters*	Number of Books in the Home*	Parents Wanting Student to Do Well in Mathematics*
Populations			
Canada	-	+	+
Alberta	0	+	+
British Columbia	-	+	+
Manitoba - English	-	+	0
Manitoba - French	0	+	0
N. Bruns. - English	-	+	+
N. Bruns. - French	-	+	0
Newfoundland	0	+	0
Nova Scotia	0	+	+
Ontario - English	-	+	+
Ontario - French	0	+	0
Quebec - English	0	+	+
Quebec - French	0	+	0
Sask. - English	0	+	0
Sask. - French	0	+	0
Other Interesting Comparisons			
China	-	+	+
Hungary	-	+	0
Jordan	0	+	+
Korea	-	+	+
Soviet Union	-	+	0
Switzerland	-	+	0
Taiwan	-	+	+
United States	0	+	+

* Student Questionnaire
+ Statistically significant positive relationship
- Statistically significant negative relationship
0 No statistically significant linear relationship

The amount of time students spend in various out-of-school activities provides for some interesting comparisons.

Figure 4.9. Mathematics, Age 13: Home Activities* and Average Percent Correct

	Average Percent Correct	Percent of Students Who:			
		Read for Fun Almost Every Day	Spend 2 Hrs or More on all Homework Every Day	Watch Television for 5 Hrs or More Every Day	Have Positive Attitudes Toward Math**
Populations					
Canada	62	38	27	14	94
Alberta	64	40	20	12	91
British Columbia	66	40	25	13	89
Manitoba - English	58	35	16	18	88
Manitoba - French	63	42	19	15	90
N. Bruns. - English	58	37	16	19	88
N. Bruns. - French	61	31	17	16	93
Newfoundland	59	37	26	23	94
Nova Scotia	60	35	23	21	93
Ontario - English	58	40	28	16	94
Ontario - French	54	35	23	17	96
Quebec - English	66	33	29	11	95
Quebec - French	69	37	33	14	92
Sask. - English	62	40	13	13	91
Sask. - French	68	45	15	9	93
Other Interesting Comparisons					
China	80	28	44	7	79
Hungary	68	44	58	13	85
Jordan	40	24	56	7	77
Korea	73	11	41	11	71
Soviet Union	70	47	52	17	76
Switzerland	71	51	20	7	85
Taiwan	73	19	41	10	79
United States	55	28	29	20	90

* Student Questionnaire

** Students in the assessment were asked to what extent they agreed with the following statements: Mathematics is useful in solving everyday problems, It is important to know some math to get a good job; I am good at mathematics; My parents want me to do well in mathematics.
Their responses were combined to form an index of attitudes toward mathematics.

Figure 4.10 shows whether the relationship between achievement and increasing levels of a particular home-activity variable is positive, negative, or not related for each population. A study of the association between home activities and mathematics performance within populations relates the importance of how students spend their time away from school.

Figure 4.10. Mathematics, Age 13: Relationship of Home Activities and Average Percent Correct Within Populations

	Amount of Leisure Reading*	Amount of Time Spent on All Homework*	Amount of Time Spent Watching Television*	Students' Attitudes Toward Mathematics*
Populations				
Canada	+	-	-	+
Alberta	+	0	-	+
British Columbia	+	0	-	+
Manitoba - English	+	-	-	+
Manitoba - French	+	-	-	0
N. Bruns. - English	+	0	-	+
N. Bruns. - French	+	-	-	+
Newfoundland	+	0	0	+
Nova Scotia	+	0	-	+
Ontario - English	+	-	-	0
Ontario - French	+	0	-	+
Quebec - English	+	-	-	+
Quebec - French	+	0	-	+
Sask. - English	+	-	-	+
Sask. - French	+	0	-	+
Other Interesting Comparisons				
China	+	0	0	0
Hungary	+	+	-	0
Jordan	0	+	0	+
Korea	+	0	-	+
Soviet Union	+	+	0	+
Switzerland	0	0	0	0
Taiwan	+	+	-	+
United States	+	0	-	+

* Student Questionnaire
\- Statistically significant negative relationship
\+ Statistically significant positive relationship
0 No statistically significant linear relationship

Observations (Figures 4.7, 4.8, 4.9, and 4.10)

Many factors are related to student performance. This study addressed some of them.

In every population, mathematics achievement is positively related to the number of books in the home. This relationship supports the importance of language in relation to performance.

Most students in every population think that their parents want them to do well in mathematics. However, a lower percentage of students report that they discuss their mathematics class with someone at home. Support from a student's parents clearly contributes to better mathematics performance (Figure 4.8).

Results indicate that parents help their children more often with their mathematics homework than with their science homework. Approximately three-quarters of students in Alberta, British Columbia, Newfoundland, Ontario (English), Saskatchewan (English), the United States, and Hungary indicated that they receive help at home with their mathematics homework. Curiously, in China, the top-performing population, students spend more time on homework and receive less help at home than do students in other populations.

The information reported on home activities and mathematics achievement is similar to that reported for science. Regular reading is positively related to achievement in the majority of populations. However, the lowest percentage of daily readers are in Korea (11%) and Taiwan (19%), both high-performing countries. In China, the top-performing country, only 28% of students report that they read for fun on a daily basis. In Alberta, 40% of participants report daily leisure reading.

As in Science, there is a negative relationship between time spent on all homework and mathematics achievement in Canada. In contrast, there is a positive relationship between time spent on all homework and mathematics achievement in the majority of populations. Compared with other populations, Alberta reports a relatively low percentage of students spending two hours or more on all homework every day. Results for Alberta show no effect on achievement with increased time spent on homework.

In many populations, there is a significant negative relationship between increased time spent watching television and mathematics performance. North American children report that they spend more time watching television than do children in other countries. Twelve percent of participants in Alberta report watching five hours or more of television every day. In Alberta, as in many other populations, math achievement decreases as time spent watching television increases.

Figure 4.11 probes student attitudes toward mathematics. The percentage of males and females agreeing with the statements is reported for Alberta's students.

Figure 4.11. Mathematics, Age 13: Attitudes Toward Mathematics* and Average Percent Correct

	Average Percent Correct	Percent of Students Agreeing with Statement:					
		I am Good at Math.	Math is More for Boys than Girls.	Math is Useful in Solving Everyday Problems.	It is Important to Know Some Math to get a Good Job.	Learning Math is Mostly Memorizing	Knowing How to Solve a Math Problem is as Important as Getting the Right Answer.
Populations							
Canada	62	70	2	83	97	58	86
Alberta**	64	63 71/56	2 4/1	80 83/76	97 97/98	57 61/52	83 84/82
British Columbia	66	60	2	78	97	59	84
Manitoba-Engl..	58	60	2	74	95	56	81
Manitoba-French	63	73	2	80	93	61	88
N. Bruns.-Engl.	58	54	2	78	95	51	83
N. Bruns.-French	61	70	2	83	95	75	91
Newfoundland	59	66	2	84	98	58	86
Nova Scotia	60	63	1	84	98	45	82
Ontario - English	58	68	2	84	98	59	84
Ontario - French	54	77	3	88	98	70	91
Quebec - English	66	67	2	79	96	44	83
Quebec - French	69	78	1	84	94	56	89
Sask. - English	62	64	2	79	97	57	87
Sask. - French	68	73	2	86	92	60	86
Other Interesting Comparisons							
China	80	57	1	80	66	19	67
Hungary	68	32	5	72	93	54	88
Jordan	40	76	15	50	77	41	82
Korea	73	22	27	82	68	13	94
Soviet Union	70	25	14	64	85	26	78
Switzerland	71	48	8	76	90	34	89
Taiwan	73	14	15	80	81	54	87
United States	55	64	3	76	96	56	86

* Student Questionnaire

** Male/female percentages. Gender data not available for other populations.

Observations (Figure 4.11)

Having a positive attitude toward mathematics is favorably related to mathematics performance in the majority of populations. In Alberta, more male students than females see themselves as being good at mathematics. In all participating North American populations, the majority of students feel they are good at math. However, there is not a consistent pattern between student responses to the statement, "I am good at math" and performance. In Jordan, for example, 76% of students feel they are good at math, whereas in Taiwan, only 14% of participants feel this way. With the exception of China, students in the higher performing populations do not perceive themselves as being as good in mathematics as students from low-performing populations do. Although not as pronounced, a similar pattern is evident in attitudes toward science.

Students in most populations feel mathematics is useful in solving everyday problems. Most students also agree that it is important to know some math to get a good job, especially in Canada and the United States, where an exceptionally high percentage of students agree with the statement. China is below the norm, with only 66% of participating students agreeing. Alberta students (97%) believe mathematics is important for getting a good job.

Responses to the statement "Learning math is mostly memorizing" ranged from 13% to 75% of students agreeing. China, Korea, and the Soviet Union report a relatively low percentage of students indicating that mathematics is mostly memorizing. In Alberta, females are less inclined to view mathematics as mostly memorizing than are males.

The majority of students display a healthy attitude in agreeing that knowing how to solve a mathematics problem is as important as getting the right answer.

SECTION 5: GEOGRAPHY RESULTS

The geography assessment was conducted as a minimal attempt to measure basic geography skills and was not planned to reflect a full range of geography knowledge and skills that might be considered important. International differences in performance on the geography assessment were not as pronounced as they were on the mathematics and science assessments. In every participating population, students achieved the highest average percent correct on questions that measured the content area of geographic skills and tools.

Nine countries including eight Canadian provinces administered this optional geography component. Nova Scotia and Prince Edward Island did not take part. In Alberta, 2881 students wrote the geography assessment and answered related background questions.

The information is displayed in the following way: geography performance of 13-year-olds, topics that students report studying, and communication with parents and student activities.

Summary of Geography Information

There appear to be positive relationships between many background variables (books in the home, study of geographic topics, reading habits, international travel) and achievement in geography. The correlations between these factors should be investigated more fully along with other background variables such as the different geography courses of study, student access to geographic reference materials, and student attitudes toward geography. For example, geography is not a separate subject in Alberta but is integrated into other subject areas. This fact needs to be considered when interpreting results. Overall, Alberta students demonstrate a good grasp of the geography concepts assessed. Alberta performed in the top third compared with other participants.

Geography Performance of 13-Year-Old Students

Figure 5.1 shows the overall results for participating populations. It reports performance on three main content and skill categories. Below is a brief description of each topic.

Skills (Geographic Skills and Tools): Students show skill in using and interpreting information from maps, charts, and globes.

Physical (Physical Geography): Students can identify physical features of land forms from maps and show an understanding of basic concepts of climate.

Cultural (Cultural Geography): Students show an understanding of the location of cultural entities, such as countries, regions, language groups, and population concentrations, as well as an understanding of human impact on the environment.

Figure 5.1 shows overall performance for all populations that chose to participate in the Geography option.

Figure 5.1. Geography, Age 13: Distribution of Percent Correct Scores by Country/Province

	Overall Average (%)	Topic		
		Skills	Physical	Cultural
Populations				
IAEP II Average	61	68	60	57
Canada	63	70	61	58
Alberta	65	71	62	61
British Columbia	67	71	67	64
Manitoba - English	63	68	63	58
Manitoba - French	61	67	59	56
N. Bruns. - English	57	63	57	50
N. Bruns. - French	55	60	54	50
Newfoundland	57	65	56	49
Ontario - English	62	68	61	58
Ontario - French	52	60	49	48
Quebec - English	67	72	64	64
Quebec - French	64	72	61	58
Sask. - English	63	71	60	58
Sask. - French	61	69	58	56
Other Participating Countries				
Hungary	70	76	68	65
Ireland	59	63	60	52
Korea	60	68	52	60
Scotland	58	66	57	51
Slovenia	65	68	64	64
Soviet Union	63	72	61	53
Spain	60	62	59	59
United States	62	69	58	58

Figure 5.2 shows performance scores and the percentage of students who report studying particular sub-topics in school.

Figure 5.2. Geography, Age 13: Percentage of Students Who Report Studying Topics* and Average Percent Correct

		Percent of Students Who Reported Studying Topic in School						
		Geography Skills & Tools			Physical Geography		Cultural Geography	
	Average Percent Correct	Reading Symbols on Maps & Globes	Using Scales to Measure Distance	Longitude and Latitude	Location of Continents, Oceans, Rivers, Mountains	Climate & Natural Resources	Location of Cities & Regions in Your Own Country	Location of Foreign Countries & Cultures
Populations								
Canada	63	91	88	94	91	84	89	75
Alberta	65	89	87	96	91	86	93	84
British Columbia	67	92	90	92	91	67	82	81
Manitoba - English	63	89	83	92	92	85	88	78
Manitoba - French	61	80	88	93	89	81	84	66
N. Bruns. - Engl.	57	79	73	76	81	60	86	59
N. Bruns. - French	55	82	83	91	89	85	88	73
Newfoundland	57	93	92	96	91	88	85	86
Ontario - English	62	92	87	95	92	87	90	75
Ontario - French	52	83	87	95	89	89	87	70
Quebec - English	67	93	89	97	95	81	90	74
Quebec - French	64	90	94	95	94	86	89	69
Sask. - English	63	90	88	96	91	86	91	81
Sask. - French	61	76	88	96	87	89	86	76
Other Participating Countries								
Hungary	70	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Ireland	59	70	67	71	84	76	85	66
Korea	60	65	80	74	85	85	82	81
Scotland	58	87	81	75	87	80	76	64
Slovenia	65	83	80	95	92	95	87	90
Soviet Union	63	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Spain	60	54	69	88	93	92	91	76
United States	62	94	91	94	94	84	89	82

* Student Questionnaire.
N/A Information is not available.

Observations (Figure 5.2)

Alberta students report that they learn geography concepts in school in spite of not having a separate geography curriculum. This shows that geography concepts are studied through their integration into the science and social studies programs.

When looking at results for all participants, there does not seem to be a consistent relationship between student reports of having studied Physical Geography topics and their performance on Physical Geography questions. For example, over 90% of Slovenian students report that they study the Physical Geography topics and they perform quite well in this area. On the other hand, although Irish students report less emphasis on the two Physical Geography topics, they were the only group that, in relative terms, performed better on Physical Geography items than on the total assessment.

The IAEP II average on the Cultural Geography topics indicates that students did not perform as well on Cultural Geography questions as they did on the other two topics. Overall, there is a comparatively lower number of students that report studying the location of foreign countries and cultures. Ireland, Scotland, and New Brunswick (English) report the lowest percentage of students studying the location of foreign countries and cultures; these populations scored low on Cultural Geography in this assessment.

Communication with Parents and Student Activities

The information in Figure 5.3 is interesting and may suggest topics and questions for further study on future assessments.

Figure 5.3. Geography, Age 13: Communication With Parents, Student Activities* and Average Percent Correct

	Average Percent Correct	Percent of Students Who:			
		Have Traveled More than 125 Miles from Home Town	Have Traveled Outside Own Country	Read for Fun almost Every Day	Never or Hardly Ever Read for Fun
Populations					
Canada	63	96	79	38(67)**	16(60)**
Alberta	65	98	76	39(67)	18(61)
British Columbia	67	97	86	39(70)	17(61)
Manitoba - Engl.	63	96	82	36(66)	21(58)
Manitoba - French	61	96	87	43(64)	12(55)
N. Bruns. - Engl.	57	94	77	37(60)	22(52)
N. Bruns. - French	55	94	55	29(60)	19(50)
Newfoundland	57	93	42	38(59)	18(53)
Ontario - English	62	97	86	39(66)	16(57)
Ontario - French	52	96	67	34(57)	16(47)
Quebec - English	67	96	88	38(69)	14(63)
Quebec - French	64	92	61	32(68)	14(59)
Sask. - English	63	98	69	38(67)	19(59)
Sask. - French	61	98	82	45(63)	11(55)
Other Participating Countries					
Hungary	70	N/A	N/A	44(75)	3(64)
Ireland	59	89	N/A	41(63)	16(52)
Korea	60	71	3	11(68)	13(53)
Scotland	58	94	68	38(62)	16(51)
Slovenia	65	85	81	42(67)	8(59)
Soviet Union	63	N/A	N/A	47(66)	10(56)
Spain	60	89	38	35(63)	13(57)
United States	62	95	39	29(66)	21(59)

* Student Questionnaire N/A Information is not available

** Average Percent Correct ( ).

Observations (Figure 5.3)

There are many interesting bits of information that need more research. For example, a relatively high percentage of students report travel outside their home country. Does traveling abroad support improved learning and higher performance? More research is needed.

In every population, students who report reading for fun every day consistently achieve a higher average percent correct than do students who read less often or not at all. This consistent, positive relationship between reading and achievement is also evident in mathematics and science. Hungary, the highest performing country in the study, reports only 3% of students that never or almost never read for fun. Korea reports a relatively low percentage of students that read for fun on a daily basis, but daily readers score on average 15 percentage points higher than students who never or almost never read. These figures support the positive impact of reading on performance. As in mathematics and science, other factors must contribute to the explanation of the higher performances of Korean students.

FINAL WORD

IAEP II has provided a great amount of data that lead us to reflect on possible reasons why students in some countries do better than students in others. A number of variables examined in the study were associated with differences in curriculum, study conditions, cultural and family values. While very few were found to be clearly related to student performance, there are hints about the importance of some, such as instructional time and the prevalence of books in the home.

While there is a need for caution in interpreting results such as these, because of the significant variations among countries, this international perspective is very important in our reflections on how well our students are doing in various areas. The trends observed here can help us, at least in part, to understand better the learning environment in Alberta.

APPENDIX 1: Overall Summary of Test Administration by Country and Canadian Province for Age 9 and Age 13*

	Scheduled Assessment Month	Who Gave Test	Test Administrator Training	Practice Test Used	Percent of Sites Visited	Percent of Accurate Scores**
Brazil	Sept '90	External Administrators	Yes	No	23	99.5
Canada						
Alberta	March '91	School Personnel	No	No	20	99.7
British Columbia	March '91	School Personnel	No	No	Informal	99.5
Manitoba	March '91	School Personnel	Yes	No	18	99.6
N. Brunswick-Engl.	March '91	School Personnel	Yes	Optional	15	99.8
N. Brunswick-Fr.	March '91	School Personnel	Yes	Yes	39	-
Newfoundland	March '91	School Personnel	No	No	21	99.0
Nova Scotia	March '91	School Personnel	No	No	21	99.9
Ontario	March '91	School Personnel	Yes	Yes (9) Optional (13)	19	98.1
Quebec	March '91	School Personnel	Yes	Yes	22	98.2
Saskatchewan	March '91	School Personnel	No	No	Informal	99.3
China	March '91	School Personnel	Yes	No	19	99.6
England	March '91	School Personnel	No	No	Informal	99.4
France	March '91	School Personnel	Yes	Yes	21	99.5
Hungary	March '91	School Personnel	Yes	No	16	99.6
Ireland	March '91	School Personnel	No	No	Informal	99.4
Israel	March '91	School Personnel	Yes	No	19	99.5
Italy	March '91	School Personnel	Yes	No	21	99.6
Jordan	March '91	School Personnel	Yes	Yes	24	100.0
Korea	Sept '90	School Personnel	Yes	Yes	20	98.0
Mozambique	Sept '90	External Administrators	Yes	No	Informal	99.3
Portugal	March '91	External Administrators	Yes	Yes (9) No (13)	20	99.5
Scotland	March '91	School Personnel	No	Optional (9) No (13)	Informal	Not Done
Slovenia	March '91	External Administrators	Yes	Optional	10	99.8
Soviet Union	March '91 (9) April '91 (13)	School Personnel	Yes	Yes	52	99.3
Spain	March '91	External Administrators	Yes	Optional (9) No (13)	20	99.7
Switzerland	March '91	School Personnel	Yes	No	Informal	-
Taiwan	March '91	School Personnel	Yes	No	20	99.8
United States	March '91	School Personnel	No	No	16	99.8

* Complete results for all countries can be found in the *Learning Mathematics* and *Learning Science* reports.

** This number represents the mean of the percent of accurate scores by scorers for constructed-response questions.

APPENDIX 2: Quality Control Procedures

Translations of Assessment Materials Independently Verified

Achievement and background questions and pupil directions were adapted and translated within each country and then checked independently by language experts in the United States. All countries used the same artwork and physical layouts for their tests.

Pilot Test of Assessment Questions

Achievement and background questions were pilot-tested with groups of pupils from each participating country (except Slovenia, which joined the project late) to determine which questions would work best in the final assessment.

Samples Independently Verified

Samples for each population were drawn using agreed-upon procedures and were independently checked in the United States to ensure that procedures were followed accurately and that sampling weights were appropriately calculated.

Procedural Manuals and Training Provided

Procedural manuals were developed for coordinating the project, drawing samples, administering the assessments, conducting a quality control program, and entering results into a database. Regional training sessions were held at which the individuals from each assessment centre who actually performed the tasks were provided detailed instructions and hands-on experience.

Computer Software Provided

Specially developed computer software was provided to the participants to facilitate sampling and data entry and to ensure uniformity and quality.

Standardized Test Administration

Test booklets were administered to students using the same instructions and the same time limits in each participating country. To ensure procedures were understood, test administrators, usually school personnel, were trained in 20 out of 29 assessment centres.

On-site Observation of Assessments

Unannounced observations of the test administrations were conducted by all assessment centres.

Independent Quality Control

In all countries except Brazil and Mozambique, an independent, trained observer interviewed the country project manager about all aspects of the project and visited one or more test administration sites. In most cases, the observer was fluent in the language of the assessment.

Data Files and Data Analysis Validated

The scoring of open-ended mathematics questions was checked in 10 percent of the booklets by 27 out of 29 assessment centres and in all cases, accuracy of scoring was 98 percent or higher. Each country validated its own data files, using software provided by the project, to ascertain their quality and accuracy. Data files were also independently validated by comparing the responses of a random set of 10 student booklets and 10 school questionnaires of each type to the data entered into the databases. If data files contained 1 percent errors or greater, participants were asked to rekey all the responses. This happened in one case. Data analysis procedures were checked by calculating statistics using different programs and computer equipment and comparing the results.

Assessment Questions Checked for Curricular or Cultural Bias

Assessment results were checked to verify that responses to individual questions could be summarized without misrepresenting curricular or cultural differences within particular countries. Cluster analyses and analyses of differential item functioning (DIF) resulted in the removal of one mathematics questions at each age level, two science questions at age 9, and eight at age 13 before final analyses were conducted.